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AUTOMATION OF HOLE MAKING PROCESS WITH IN-LINE HOLE CONFIGURATION

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ABSTRACT
One of the machining processes that is often used in the industrial world is the drilling process (hole making process). The hole making process can be done manually or automatically depending on the needs. In the manufacture of products with a low level of accuracy and small quantities, the manual process is very effective to use, but in the manufacture of products with a high level of accuracy and large quantities, the manual process is no longer effective to use. Therefore, a process is needed that works automatically so that the results of the work are as expected. Automatic control systems can be done using microcontrollers, computers, PLCs, or circuits consisting of control components. The control components that are often used are relays, timers and counters. This final project will discuss the performance of the drilling machine in making several holes in a row and applying it with a control system. The automatic control system is used to move the workpiece holder (vice) and the drilling machine. The control components used are relays, timers, counters and limit switches. These control components are used as controllers on the workpiece holder and drilling machine controllers.

Keywords: *Machine controllers, CNC, Drilling, automatic control PLC.*

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Introduction
The use of automatic machines in the production sector is a technology that is currently being developed by humans. Repetitive human work often reduces work concentration. Automatic control systems can do repetitive work without reducing the quantity and quality of production of a product. In automatic control systems, humans only act as operators. Automatic control systems will be more profitable if carried out in more complicated processes. This basic idea is the main foundation for a company in following the development and progress of industrial technology today. Automatic control systems can be carried out using microcontrollers, computers, PLCs, or circuits consisting of control components. The control components that are often used are relays, timers and limit switches. Relay ladder logic is a wiring diagram that is specifically used as a programming language for relay and switching control circuits. Therefore, automatic control systems can lighten human work and maintain production quality.

AC Motor
Based on the characteristics of the electric current flowing, AC (Alternating Current) motors consist of 2 types, namely:
1-phase AC/alternating current electric motor
3-phase AC/alternating current electric motor

Working principle of Single Phase AC Motor
A single-phase AC motor works differently from a three-phase AC motor, where in a three-phase AC motor for the stator winding there are three windings that produce a rotating field and in the cage rotor there is induction and torque interaction that produces rotation. While in a single-phase motor there are two stator windings, namely the main phase winding (winding U1-U2) and the auxiliary phase winding (winding Z1-Z2), see figure

The main winding uses a larger copper wire cross-section so that it has a smaller impedance. While the auxiliary winding is made of small-section copper and the number of turns is greater, so its impedance is greater than the impedance of the main winding.

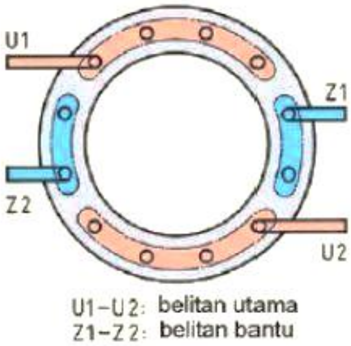


Figure Principle of the main magnetic field and auxiliary magnetic field of a single-phase motor

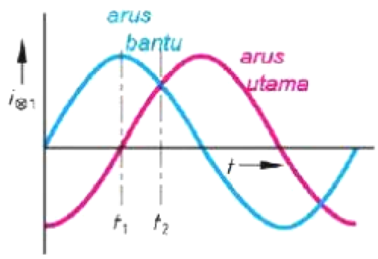


Figure Waveform graph of auxiliary field current and main field current

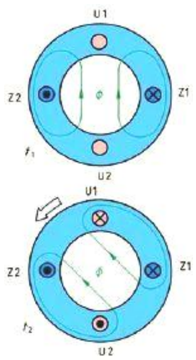


Figure Magnetic field in the stator of a single-phase motor

The auxiliary winding Z1-Z2 is first supplied with auxiliary current producing a perpendicular magnetic flux Φ, a few moments later the main winding U1-U2 is supplied with the main current. which has a positive value. The result is a magnetic field that shifts by 45° in a counterclockwise direction. This event continues until one sinusoidal cycle, resulting in a rotating magnetic field in the stator winding. DC (Direct Current) motor is an electronic device that can convert electrical energy into kinetic energy. DC motors can rotate in the direction of the clockwise rotation or can also rotate counterclockwise.

In its application, a DC motor is often rotated in two directions of rotation, namely clockwise and counterclockwise. The direction of rotation of a DC motor can be changed by changing the direction of the electric current flowing through the DC motor. Changing the direction of the electric current passing through the DC motor can be done by changing the polarity of the motor voltage.

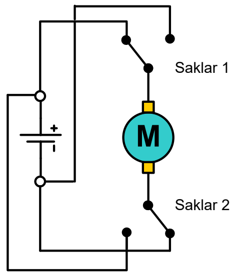


Figure Changing the direction of rotation of a DC motor using two switches.

Proximity Sensor

A proximity sensor is a sensor or switch that can detect the presence of a metal target without physical contact. Usually this sensor consists of a solid-state electronic device that is tightly wrapped to protect it from excessive vibrations, chemical fluids and corrosives.
In simple terms, the working principle of a proximity sensor is by bringing the sensor closer to a metal object at a certain distance, the sensor output is active, as a result the sensor output changes condition from low to high. Each type of proximity sensor has a different detection distance, namely 5, 7, 10, 12 and 20 mm. the shape of the proximity sensor can be seen in Figure

Figure Proximity sensor shape

Limit switch
A limit switch (LS) is an electronic device that can be used to disconnect or connect an electrical circuit. Simply put, a limit switch consists of two metal blades attached to a circuit, and can be connected or separated according to the connected (on) or disconnected (off) state in the circuit. The shape of the limit switch can be seen in Figure

Figure *Limit switch*

Relay

A relay is an electronic device that can connect and disconnect the flow of electric current from two terminals whose conditioning is regulated by a coil. There are only two relay conditions, namely connecting or disconnecting the flow of electricity from two terminals or in other words on or off.

The terms on and off are very important because any electrical device that requires an electrical energy source definitely requires an on or off condition to start or end its work.
Because its working system is regulated or controlled by a coil, this tool is the most important tool in the line of electromagnetic control system tools. Its working system can be interconnected, thus forming a sequence or process of an event called automation. The types and types of relays vary according to the function and requirements of the device it controls. One type of relay can be seen in Figure 2.13. The relay in Figure 2.13 is a MY4N type relay with a working voltage of 12Vdc. Its contacts are capable of conducting a maximum current of 5A for a voltage of 240 Vac and 28 Vdc

Figure Relay type MY4N

MECHANICAL DEVICE CREATION AND DRILL MACHINE CONTROL PROGRAM

Mechanical Devices

The mechanical device in the process controller of making several holes using this drill machine consists of a workpiece holder (vice), a drill machine. The mechanical device controlling the process of making holes using a drill machine can be seen in the picture

Figure Mechanical Devices

The 2nd AC electric motor or spindle motor (M.G) is used to rotate the spindle. The placement of the AC2 electric motor (M2) used to rotate the spindle can be seen in the picture.

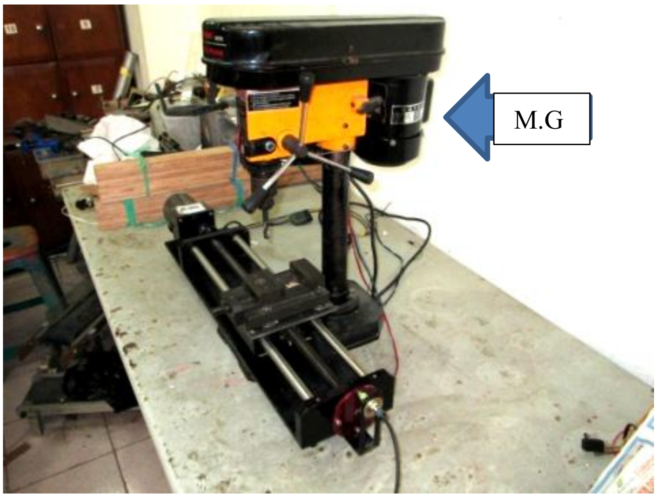
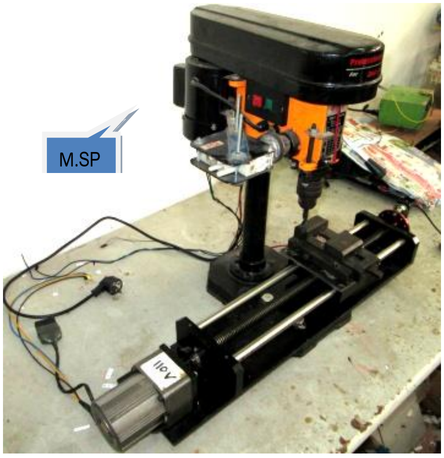


Figure. Placement of the 2nd AC electric motor (MG) on the drill

DC electric motor (M.SP) is used to drive the spindle on the drilling machine so that the spindle can move down and up. The placement of the DC electric motor used to drive the spindle can be seen in the picture



3.2 Control Circuit Algorithm

The assembled automatic hole making process mechanical device cannot operate without a control system. The control system used in the process of making several holes in a row is relay ladder logic. The components of the control system used consist of proximity sensors, relays, timers and counters. The control system is installed according to the programming sequence into one circuit with the mechanical device so that it can function according to the purpose of manufacture.
In order for the control of the process of making several holes automatically to be realized according to the purpose of manufacture, the control process needs to be described into a control process algorithm. The control circuit algorithm for the process of making several holes using a drilling machine consists of several parts
The ladder diagram of the process of making several holes in a row automatically which has been described into eight descriptions, then combined into one ladder diagram. The combined ladder diagram can be seen in the picture.

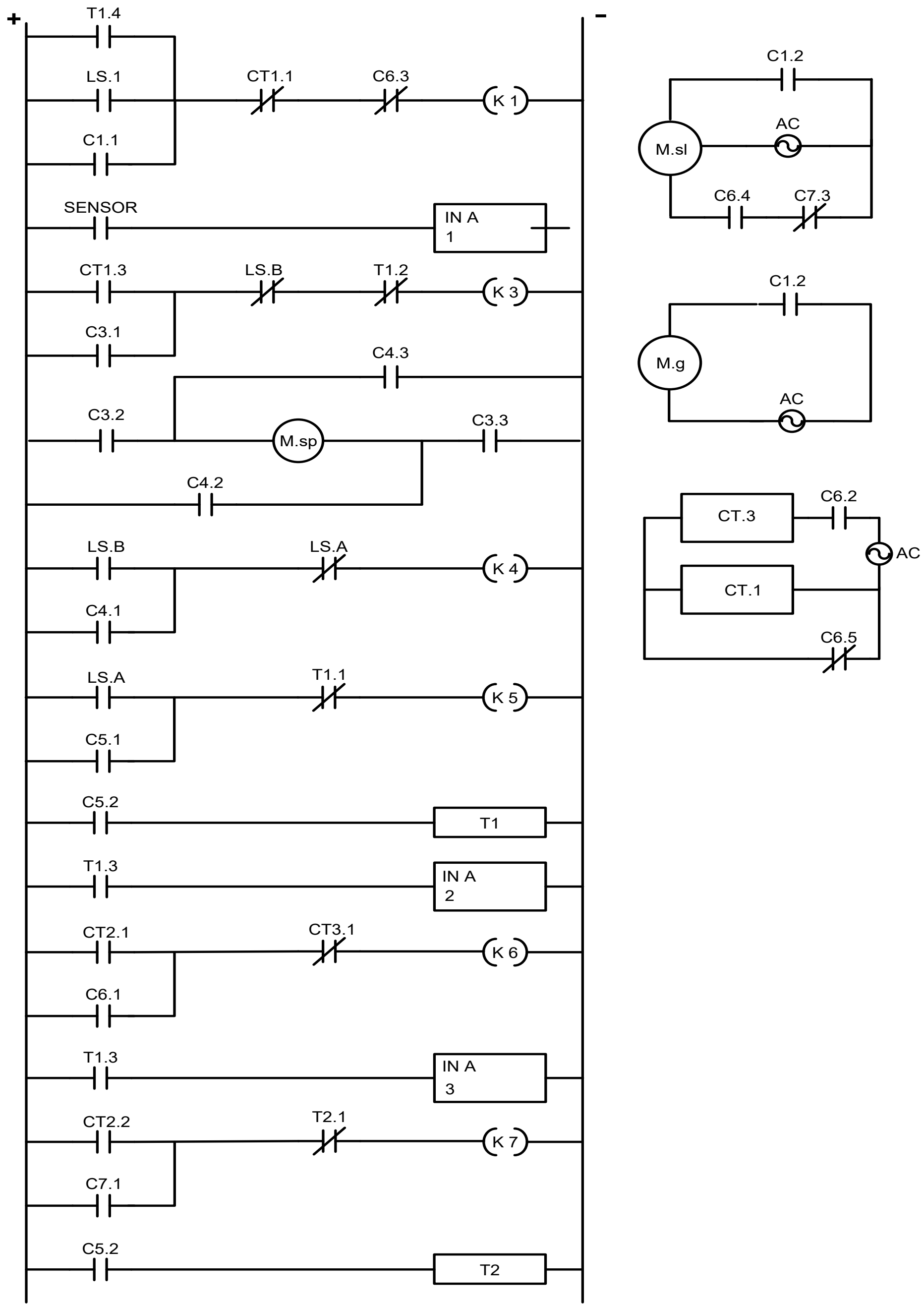


Figure Overall Staircase Diagram

After making a ladder diagram (ledger diagram) the control circuit can be installed according to the control logic flow. The control device that has been installed according to the control logic sequence of the process of making several holes in a row can be seen in the picture.

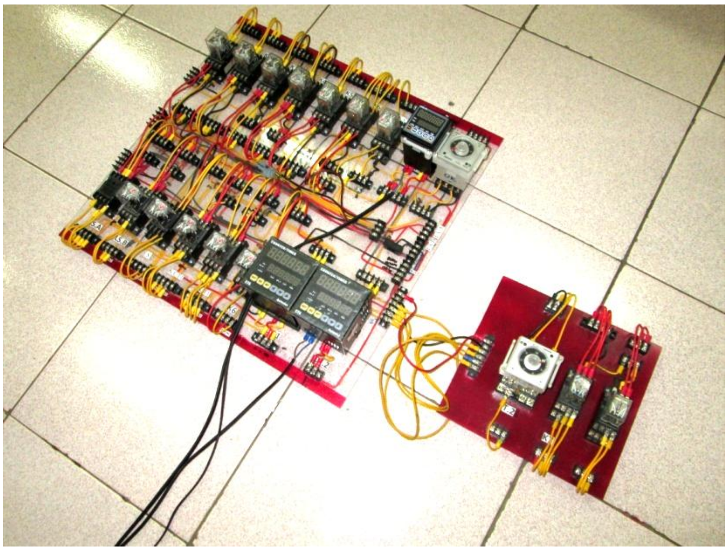


Figure Control Devices That Have Been Installed According to the Sequence of Control Logic

RESULTS AND DISCUSSION

Testing the Process Control of Making Multiple Holes in a Row on a Wooden Block Workpiece.

Testing the bench drill machine that has been assembled with a slider and using a relay lader logic control system aims to ensure whether the machine can work according to the manufacturing objectives. The test is carried out by clamping and positioning the workpiece in a vise, then the start button (limit switch1) is clicked to carry out the process of making multiple holes in a row and the workpiece is released from the vise.

The test was carried out on a wooden block with a length of 440mm, a width of 40mm and a thickness of 10mm, 5 times and the holes made on each workpiece were 7 holes. The wooden block that had been drilled was measured and recorded, measurements were carried out 3 times. The test result data can be seen in the attachment.

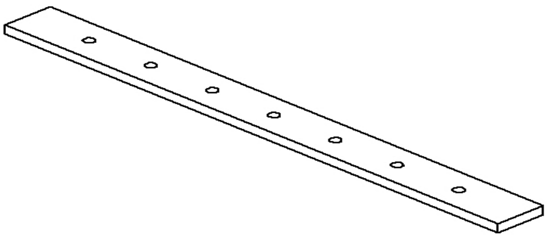


Figure Workpiece A

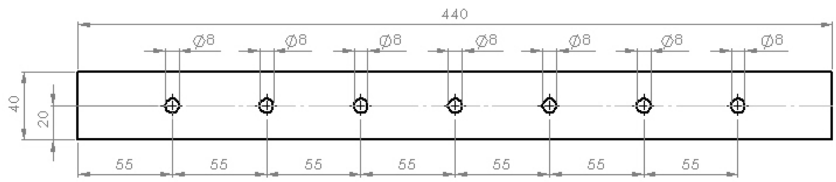


Figure Workpiece B

Measurement process

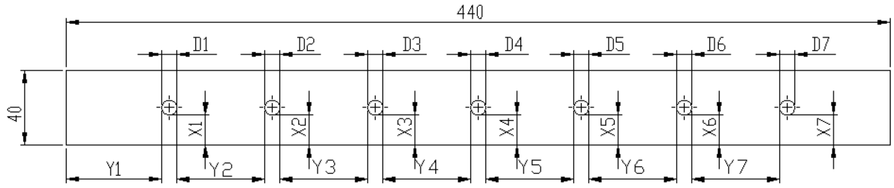


Figure Workpiece Measurements

Description:
X = Distance from the edge of the circle to the edge of the nearest circle.
XC = Distance from the center of the circle to the center of the nearest circle.
Y = Distance from the edge of the circle to the bottom of the workpiece.
YC = Distance from the center of the circle to the bottom of the workpiece.
D = Hole diameter.

Analysis of Test Results

The measurement results of the 1st workpiece that have been averaged can be seen in table 4.1 and the test result graph can be seen in graph The measurement results of the 2nd, 3rd, 4th and 5th workpieces can be seen in the attachment

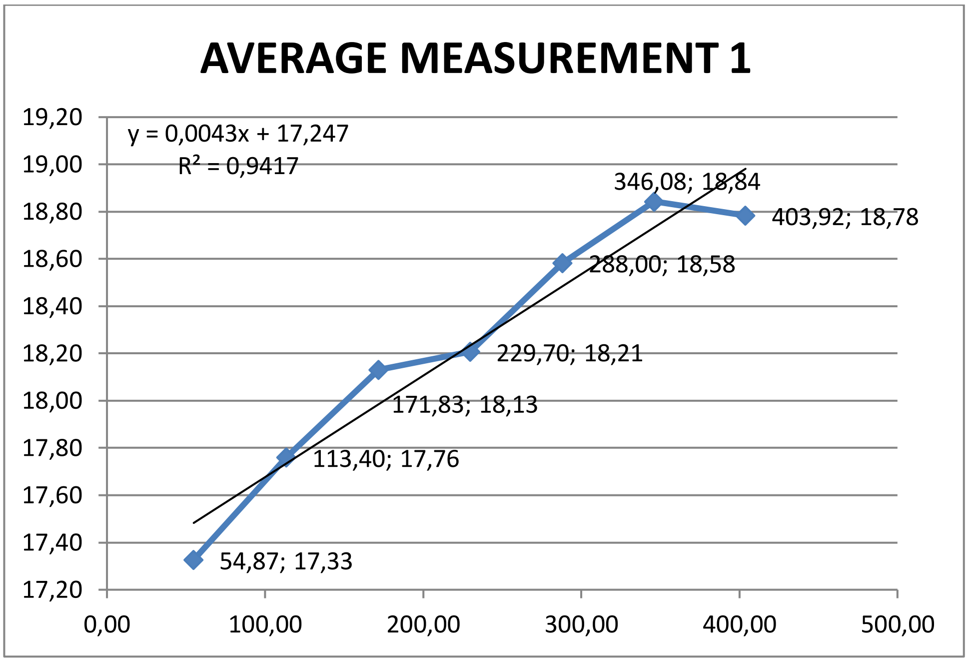
Table Results of Test 1

AVERAGE MEASUREMENT 1					
NO	Hole	(X)	(XC)	(Y)	(YC)
1	8.61	50.56	54.87	13.02	17.33
2	8.65	49.90	113.40	13.43	17.76
3	8.62	49.79	171.83	13.82	18.13
4	8.76	49.18	229.70	13.83	18.21
5	8.61	49.62	288.00	14.28	18.58
6	8.69	49.43	346.08	14.50	18.84
7	8.69	49.15	403.92	14.44	18.78

Table is the result of calculating deviations from the 1st test, in the 1st test the largest deviation was found in the 6th hole. The results of calculating deviations from tests 2 to 5 can be seen in the attachment.

Table Test Deviation 1

Lubang Ke	ax	by	ax+by+c	$\sqrt{a^2+b^2}$	CT
1	0.22	-17.33	0.13	1.00	0.13
2	0.45	-17.76	-0.07	1.00	0.07
3	0.69	-18.13	-0.20	1.00	0.20
4	0.92	-18.21	-0.05	1.00	0.05
5	1.15	-18.58	-0.19	1.00	0.19
6	1.38	-18.84	-0.22	1.00	0.22
7	1.62	-18.78	0.07	1.00	0.07



CONCLUSION

After assembling, testing and analyzing the process controller for making several inline holes on a wooden block workpiece with a length of 450mm, a width of 40mm and a thickness of 10mm using a drill machine, several things can be concluded, namely:

1. The drill machine that has been installed with a slider cannot be used to make inline holes because the distance between the centers of the holes (XC) deviates from the desired distance, the AC motor used as the slider drive cannot stop directly causing the distance between the holes to deviate from the tolerance value (the tolerance value allowed for open sizes with nominal sizes of 30-120 is 0.3 and nominal sizes of 6-30 are 0.2).
2. The distance between the center of the hole and the edge of the lower part of the workpiece (YC) is not uniform because:
   a) The slider that was made carelessly resulted in the slider movement not being straight.
   b) The vise used was not right because when the hole was made at the end of the workpiece there was elastic deformation
3. Control devices that have been installed (proximity, limit switch, counter, relay and timer)

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